

REMARKS

Applicant has amended claim 1. Claims 1-10 are pending in this application.

In the Office Action, the Examiner rejected claims 1, 4, 5, 6 and 9 under 35 U.S.C. Section 102(b) as being anticipated by Fukushi (US Patent No. 4549191). Applicant respectfully traverses the rejection to the extent that the rejection applies to the claims as amended.

Generally, the present invention concerns an ink-jet printing head, an example of which is shown in FIGS. 4 and 5 of the present specification. The printing head includes an actuator 20 and a flow-passage unit 10. An active portion of the actuator 20 pushes ink in an ink pressure chamber 16. The ink then ejects out of the nozzle 54 downwardly in a thickness direction and away from the surface of the actuator 10 facing the flow-passage unit 10.

In an effort to increase the printing speed, an attempt was made to simply increase the maximum drive frequency of the actuator unit. The actuator's maximum drive frequency depends upon reciprocal propagation time of the pressure wave through the pressure chamber in its longitudinal (horizontal) direction. Accordingly, the maximum drive frequency can be increased by reducing the length of the pressure chamber. However, the reduced length of the pressure chamber required an increase in the drive voltage to prevent any deterioration of image quality due to lowered ink velocity. Although possible, an increase in the drive voltage results in not only an increase in the cost of manufacture of the associated components such as electric circuits and driver ICs, but also an increase in the amount of heat generation from the actuator unit, which requires the provision of additional components for dissipating the generated heat.

The present invention solves the above problems by reducing the depth of the pressure chambers by a carefully selected amount. Through extensive research and experiments, the inventor found that each pressure chamber should have a depth of 35 μm -45 μm . This feature makes it possible to increase the printing speed, without increasing the required drive voltage, without decreasing the ink ejection speed and without sacrificing printing quality. This novel feature is recited in claim 1 as "wherein each of said pressure chambers has a depth of 35 μm -45 μm in a direction perpendicular to said one of opposite surfaces of said flow-passage unit".

As noted by the Examiner, the Fukuchi reference shows pressure chambers 11 each having a depth of 30-300 μm (see col. 4, lines 41-49). Although the depth range of 30-300 μm in Fukuchi includes the specific range of 35-45 μm recited in claim 1, the reference fails to teach that the specific range of 35-45 μm is important to an ink-jet printing head in general for ejection of ink droplets at a sufficiently high velocity, and at a sufficiently high drive frequency and a low drive voltage of the actuator unit. In other words, the Fukuchi reference does not teach that the very narrow range of 35-45 μm is more desirable than the relatively broad depth range of 30-300 μm .

If the reference taught the desirable range of 35-45 μm while applicant's claim recited the broader important range of 30-300 μm , the reference would be reasonably considered to teach the claimed range. In fact, however, the situation is contrary to this assumption. Even though the reference teaches the broad desirable or preferred range of 30-300 μm , this teaching does not necessarily mean the teaching that the relatively narrow specific range of 35-45 μm is important. Nowhere in the reference is a teaching that the 35-45 μm range is important for excellent quality of printing by the ink-jet printing head in general at high printing speed and at a high drive frequency with low drive voltage.

Further, the applicant discovered that the specific depth range of 35-45 μm of the pressure chamber (16) is important in the specific type of ink jet printing head as stated in amended claim 1, that is, in the printing head wherein the flow-passage unit (10) has a flow passage (16-18) for communication between each nozzle (54) and the common manifold (11a, 12a) through the pressure chamber (16), but does not have another flow passage which does not include the pressure chamber and which is provided for communication between the nozzle and the common manifold.

Moreover, the motivation for choosing a particular depth range of the pressure chambers for the present invention is quite different from that of the Fukuchi device. In the present invention, the motivation is to reduce the drive voltage without sacrificing the ink ejection velocity. On the other hand, the motivation for the Fukuchi device is to reduce etching costs (see col. 4, lines 54-56) and to prevent air bubble from entering the ink chamber (see col. 5, lines 14-16). In other words, based on Fukuchi reference, one of ordinary skill in the art would not be motivated to choose the narrow depth range of 35-45 μm as claimed in claim 1 from the substantially broader depth range of 30-300 μm in Fukuchi.



For at least the foregoing two reasons, the applicant believes that the reference fails to show the ink-jet printing head as defined in amended claim 1.


-6-

Also, applicant submits that dependent claims 4, 5, 6 and 9 are also patentable by virtue of their dependency from independent claim 1.

The Examiner rejected claims 2, 3, 7 and 8 under 35 U.S.C. Section 103(a) as being obvious over Fukuchi in view of Usui (US Patent No. 5956059). Further, the Examiner rejected claim 10 under 35 U.S.C. Section 103(a) as being obvious over Fukuchi in view of Morikoshi (US Patent No. 6382754). Applicant respectfully submits that claims 2, 3, 7, 8 and 10 are patentable by virtue of their dependency from independent claim 1.

Based upon the above amendments and remarks, Applicant respectfully requests reconsideration of this application and its earlier allowance. Should the Examiner feel that a telephone conference with Applicant's attorney would expedite the prosecution of this application, the Examiner is urged to contact him at the number indicated below.

Respectfully submitted,

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